

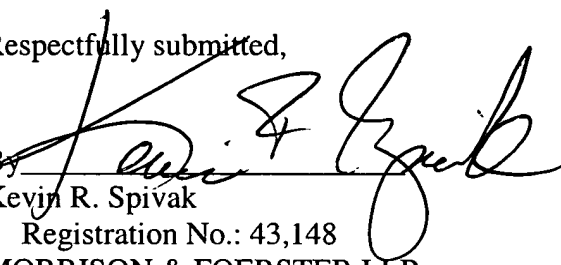
**REMARKS**

Amendments to the specification have been made and are submitted herewith in the attached Substitute Specification. A clean copy of the specification and a marked-up version showing the changes made are attached herewith. The claims have been amended in the attached Preliminary Amendment. All amendments have been made to place the application in proper U.S. format and to conform with proper grammatical and idiomatic English. None of the amendments herein are made for reasons related to patentability. No new matter has been added.

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**SUBSTITUTE SPECIFICATION  
(MARKED VERSION)**

Description

**METHOD FOR PRODUCING AN INTEGRATED CIRCUIT WITH A  
REWIRING DEVICE AND CORRESPONDING INTEGRATED CIRCUIT**

5

CLAIM FOR PRIORITY

This application claims priority to German Application  
No. 10255844.2 filed November 29, 2002, which is  
incorporated herein, in its entirety, by reference.

10

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a method for producing  
an integrated circuit with a rewiring device, and a  
15 corresponding integrated circuit.

BACKGROUND OF THE INVENTION

CSPs (chip scale packages) have to date predominantly  
been constructed on prefabricated substrate strips. In  
20 accordance with known CSP technologies based on a  
substrate, such as Tessera  $\mu$ BGA (micro ball grid array),  
for example, the rewiring (redistribution lines) or at  
least parts thereof are already integrated into the  
prefabricated substrate. Such a rewiring present on the  
25 substrate is then contact-connected by means of bonding  
wires or TAB bonding to an integrated circuit or a chip.  
The production of the substrate requires complicated and  
expensive process steps which increase the costs for the  
substrate. Furthermore, the production and the subsequent  
30 process steps are effected with a low degree of  
parallelism, e.g. in panels or strips with fewer than 150  
chips. Both causes have hitherto prevented a further  
lowering of the production costs of CSPs. Fan-out  
rewirings can also be generated by means of CSP  
35 technologies based on a substrate, for example by means  
of the BGA technology.

Wafer level package technologies (WLP) likewise provide a cost-effective technology for producing chip scale packages (CSPs), but without being able to provide fan-out rewirings. The wafer level package technologies  
5 utilize as a basis the front end wafer, on which the thin-film technique is used in order to produce the fan-in rewiring, the insulation layers, such as e.g. a solder resist layer, and the solder balls. Although the technology steps used in this case for metallization,  
10 i.e. sputtering and electrodeposition, for structure production, i.e. photolithography, and for producing protection layers, i.e. spin coating, are cost-intensive, the individual costs per chip can be kept low on account of the high degree of parallelism (entire wafer with up  
15 to 1000 chips). In addition, in the future more cost-effective printing technologies will increasingly replace the expensive photolithographic process steps. New printing technologies will make it possible to produce a mask technique using the printing method, which can be  
20 used for the highly accurate contact connection of contact pads on a wafer, typical contact pad spacings comprising 130  $\mu\text{m}$ , for example, and typical pad openings comprising 60  $\mu\text{m}$ . Printing processes can thus be used for structure production of rewiring devices or insulation  
25 wires on a new panel. However, the WLP production cannot be used to produce fan-out rewirings, i.e. rewirings which project beyond the chip edge.

#### SUMMARY OF THE INVENTION

30 ~~Therefore, the object of the~~The present invention ~~is to~~ provides a method for producing an integrated circuit with a rewiring device and ~~likewise such~~ an integrated circuit in a cost-effective manner.

35 ~~According to the invention, this object is achieved by means of the method for producing an integrated circuit with a rewiring device as specified in Claim 1 and by~~

~~means of the integrated circuit with a rewiring device according to Claim 19.~~

~~The idea on which the present invention is based~~  
5 ~~essentially consists in suitably~~The present invention  
~~combinings~~ process steps of wafer level package technologies together with substrate-based CSP technologies. Thus, prefabricated substrates with rewiring layers are avoided, rather a rewiring device is  
10 only produced during the production process of the chip scale package on a simple, large-area substrate with a high degree of parallelism.

~~In one embodiment of the present invention, the problem~~  
15 ~~mentioned in the introduction is solved in particular by virtue of the fact that~~there is a method for producing an integrated circuit with a rewiring device is provided, having the following steps:  
The method includes, for example, provision of a carrier device with predefined or  
20 subsequently patterned cutouts; application of at least one integrated circuit upside down to the carrier device  
~~in such a way~~ that the defined cutouts of the carrier device are located above at least one connection device of the integrated circuit; application of an insulation  
25 device to that side of the carrier device which is not covered by the integrated circuit, omitting the at least one connection device in the cutout; application of the patterned rewiring device to the insulation device;  
application of a patterned solder resist device to the  
30 patterned rewiring device; and patterned application of solder balls on regions which are not covered by the patterned solder resist device.

~~What is advantageous in this case~~One advantage is that  
35 the rewiring or parts thereof do not already have to be provided on a substrate or a carrier device from the outset. In addition, a fan-out design is possible, i.e.

rewirings which project beyond the chip edge.

Furthermore, the size of the carrier device may considerably exceed that of conventional substrates, e.g. with integrated rewiring layers. In particular, ~~said the~~ size may also exceed the wafer area since panel sizes of 600 mm x 400 mm can be realized even without considerable cost expenditure. ~~What is more~~ Additionally, such a carrier device or panel does not have to be round like a wafer, for example, but rather may also be formed in rectangular fashion in a manner adapted to the chip geometry.

In addition to these directly cost-effective advantages, the present invention affords further beneficial advantages in that greater freedom in the choice of materials is available, that production of multichip units, so-called multichip modules, with integrated circuits or chips of different form and size is also made possible since the population of the carrier device is not restricted to uniform chips, and in that there is a possibility for the multi-die test and burn-in after complete processing, similar to the wafer level test (WLT) and wafer level burn-in (WLBI) already known.

~~Advantageous developments and improvements of the respective subject matter of the invention are found in the subclaims.~~

In accordance with one preferred ~~development~~ embodiment, the carrier device is a film in which the at least one cutout is present, or is subsequently produced, in the form of a stamped-out hole.

In accordance with a further preferred ~~development~~ embodiment, before the application of the integrated circuit, an adhesive is applied to the carrier device.

In accordance with a further preferred ~~development~~embodiment, the carrier device is clamped in a clamping-in device such as e.g. a frame.

5

In accordance with a further preferred ~~development~~embodiment, a multiplicity of integrated circuits are applied to the carrier device by means of a placement device, such as e.g. a pick-and-place tool.

10

In accordance with a further preferred ~~development~~embodiment, a protection device is applied above the carrier device and the at least one integrated circuit applied.

15

In accordance with a further preferred ~~development~~embodiment, the protection device is applied in an injection-molding method, in a printing process or a potting process and/or is subsequently cured.

20

In accordance with a further preferred ~~development~~embodiment, a polymer is applied as the insulation device.

25

In accordance with a further preferred ~~development~~embodiment, the insulation device is printed on or produced in a photolithographic process.

30

In accordance with a further preferred ~~development~~embodiment, the patterned rewiring device is applied to the insulation device by means of ~~the following steps~~: application of a carrier metallization to the insulation device; application and patterning of a mask on the carrier metallization; application of a conductor track metallization in regions of the carrier metallization which are not covered by the patterned mask; removal of the mask; and patterning of the carrier metallization in

35

accordance with the conductor track metallization structure.

5 In accordance with a further preferred ~~development~~  
embodiment, the carrier metallization is sputtered on  
and/or the mask is patterned photolithographically and/or  
the conductor track metallization is electrochemically  
plated and/or the carrier metallization is patterned in  
an etching step.

10

In accordance with a further preferred ~~development~~  
embodiment, the solder resist device has a polymer.

15

In accordance with a further preferred ~~development~~  
embodiment, the solder resist device is printed on.

20 In accordance with a further preferred ~~development~~  
embodiment, the solder balls are applied in patterned  
fashion in a printing process and are subsequently  
reliquefied, preferably in a furnace, and solder balls  
are formed.

25 In accordance with a further preferred ~~development~~  
embodiment, a multiplicity of integrated circuits on a  
carrier device, after the application of the solder  
balls, are separated into individual integrated circuits  
or groups of integrated circuits.

30 In accordance with a further preferred ~~development~~  
embodiment, a multiplicity of integrated circuits with  
rewiring devices on the carrier device undergo a  
functional test prior to the separation.

35 In accordance with a further preferred ~~development~~  
embodiment, the patterned rewiring device is patterned in  
such a way that it extends laterally beyond the chip  
edge.

In accordance with a further preferred ~~development~~  
embodiment, multichip modules are formed, which  
preferably have different individual ICs.

5

#### BRIEF DESCRIPTION OF THE DRAWINGS

An exemplary embodiment of the invention is illustrated  
in the drawings and is explained in more detail in the  
description below.

10

In the figures:

Figures 1-10 show a ~~diagrammatic~~ cross-sectional view  
of individual stages in the production  
process of an integrated circuit with a  
rewiring device for elucidating an  
embodiment of the present invention, ~~and~~.

15

Figure 11 shows a ~~diagrammatic~~ cross-sectional view  
of an integrated circuit with a rewiring  
device for elucidating an embodiment of  
the present invention in an enlarged  
illustration.

20

25 In the figures, identical reference symbols designate  
identical or functionally identical constituent parts.

#### DETAILED DESCRIPTION OF THE INVENTION

Figure 1 illustrates a carrier device 10 provided with  
vertically continuous cutouts 11. The carrier device 10  
or the substrate is a film or a flexible substrate, for  
example, the cutouts 11 being present e.g. in the form of  
stamped holes.

30

35 In accordance with Figure 2, the carrier device 10 with  
the cutouts 11 provided therein is provided with an  
adhesive 12 at the top side and clamped into a frame 13.



Said frame 13 may have both round and angular forms and its size is limited only by the requirements in the subsequent process steps, ~~such as~~, for example, printing technique, photolithography. In particular, the size of the carrier device 10 can extend to wafer size (200 mm, 300 mm), but also beyond that.

In a subsequent process step, in accordance with Figure 3, integrated circuits 14 are applied and positioned upside down on the carrier device 10 with adhesive 12 applied thereto ~~in such a way~~ that connection devices 15, such as contact pads ~~for example~~, of the integrated circuit 14 are located in the region of the cutouts 11. In this case, the distance between the integrated circuits 14 or the distance between the cutouts 11 is preferably chosen ~~in such a way~~ that a rewiring layer that is subsequently to be created, on that side of the substrate film 10 or carrier device which is not provided with adhesive 12, can be led laterally beyond the chip edge. The integrated circuits 14 can be applied and positioned by means of a placement device, such as a pick-and-place tool, for example.

For the protection of the integrated circuits 14, in accordance with Figure 4, a protection device 16 is preferably provided above the integrated circuits 14 on the side remote from the contact pads 15. Consequently, if appropriate before the production of a rewiring device, the entire chip assembly comprising a multiplicity of integrated circuits 14 on the carrier device 10 is provided with a protection device 16 by means of an injection-molding method or another potting or printing method, which protection device is subsequently cured. A rigid composite, similar to a wafer, can be obtained as a result.

Figure 5 shows the arrangement in accordance with Figure 4 after the application of an insulation device 17 on that side of the carrier device 10 which is not provided with integrated circuits 14, no insulation device 17 being applied over the connection devices 15 or contact pads in the cutouts of the carrier device 11 ~~is it~~. The insulation device 17, preferably a polymer, is applied e.g. photolithographically or in a printing method.

10 A rewiring device 18, 19 is thereupon applied on ~~said~~ the insulation device 17 in accordance with Figure 6. The rewiring device 18, 19 has electrically conductive sections 18 or conductor track sections and electrically insulating sections 19, the conductor track sections 18 being at least partly contact-connected to the contact pads 15. The rewiring metallization 18 of the rewiring device 18, 19 is preferably formed as follows: sputtering of a carrier metallization onto the insulation device 17; application and photolithographic patterning of a mask (not illustrated); electrochemical deposition of the conductor track metallization 18 on the sputtered-on carrier metallization in sections not covered by the mask; removal of the mask; and etching of the carrier metallization patterned in such a way as the conductor track metallization 18. In addition, an electrically nonconductive material 19 may be provided laterally between the conductor track sections 18. Consequently, the rewiring layer 18, 19 is produced by means of thin-film or printing technology on that side of the carrier device 10 or substrate film which is not provided with the integrated circuits 14.

After a further method step, in accordance with Figure 7, a solder resist device 20 has been applied to the rewiring device 18, 19 in patterned fashion preferably in a printing process. Said solder resist device 20, preferably comprising a polymer, is patterned in such a

way that cutouts are provided over predetermined sections 21 of the conductor track metallization 18 of the rewiring device 18, 19.

- 5 In accordance with Figure 8, solder 22 is applied in the cutouts 21 in the solder resist device 20 over the predetermined sections 21 of the conductor track metallization 18, preferably in a printing process.
- 10 In the arrangement in accordance with Figure 9, these solder balls 22 have been reliquified, preferably in a reflow furnace, and subsequently cooled, thereby forming solder balls 22'.
- 15 Following Figure 10, the chip composite comprising a plurality of integrated circuits 14 has been divided into separated integrated circuits 23 with fan-out rewiring device 18, 19, 20.
- 20 The arrangement in accordance with Figure 11 shows in detail such a separated integrated circuit 23 which has been produced in accordance with the method according to the invention. By means of the procedure described, in a manner similar to that in the case of a prefabricated
- 25 substrate, i.e. with rewiring layers, a rewiring technology is provided which, however, according to the present invention, can be produced with a high degree parallelism and can thus be produced cost-effectively. This technology according to the invention utilizes WLP
- 30 processes, fan-out designs now also being possible. The integrated circuits 23 with rewiring device are preferably separated in a dicer.

Although the present invention has been described above

35 on the basis of a preferred exemplary embodiment, it is not restricted thereto, but rather can be modified in diverse ways.

Thus, in particular, the materials explained (polymer, ... ) are to be regarded as by way of example.

Furthermore, the rewiring device 18, 19, 20, 22 can also  
5 be produced in an alternative way.

~~Patent Claims~~ What is claimed is:

SUBSTITUTE SPECIFICATION  
(MARKED VERSION)

Abstract

**METHOD FOR PRODUCING AN INTEGRATED CIRCUIT WITH A  
REWIRING DEVICE AND CORRESPONDING INTEGRATED CIRCUIT**

The present invention provides a method for producing an integrated circuit ~~(23)~~ with a rewiring device ~~(18, 19)~~, having the following steps: In the method, there is provision of a carrier device ~~(10)~~ with defined cutouts ~~(11)~~; application of at least one integrated circuit ~~(14)~~ upside down to the carrier device ~~(10)~~ in such a way that the defined cutouts ~~(11)~~ of the carrier device ~~(10)~~ are located above at least one connection device ~~(15)~~ of the integrated circuit ~~(14)~~; application of an insulation device ~~(17)~~ to that side of the carrier device ~~(10)~~ which is not covered by the integrated circuit ~~(14)~~, omitting the at least one connection device ~~(15)~~ in the cutout ~~(11)~~; application of the patterned rewiring device ~~(18, 19)~~ to the insulation device ~~(17)~~; application of a patterned solder resist device ~~(20)~~ to the patterned rewiring device ~~(18, 19)~~; and patterned application of solder balls ~~(22)~~ on sections ~~(21)~~ of the rewiring device ~~(18)~~ which are not covered by the patterned solder resist device ~~(20)~~. The present invention likewise provides such an apparatus.

**Figure 11**

**SUBSTITUTE SPECIFICATION  
(MARKED VERSION)**

## List of reference symbols

- 10 Carrier device, preferably flexible, e.g. film
- 11 Cutout in carrier device, e.g. stamped
- 12 Adhesive
- 13 Frame
- 14 Integrated circuit
- 15 Connection device, e.g. contact pads
- 16 Protection device
- 17 Insulation device, preferably a polymer
- 18 Conductive device, e.g. conductor track metallization
- 19 Nonconductive device
- 20 Solder resist device, preferably a polymer
- 21 Section of the conductor track metallization that is not covered by solder resist device (cutout in polymer)
- 22 Solder ball
- 22' Reliquefied solder ball
- 23 Separated integrated circuit with fan-out rewiring device